



International GPS Service

INTERNATIONAL CONTINUOUSLY OPERATING REFERENCE STATIONS: RESOURCES FOR PRECISE POSITIONING

2002

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<http://igscb.jpl.nasa.gov>





Acknowledgements

- > **It is important to recognize the significant contributions of the IGS components: station and network operators, data centers, analysis and associate analysis centers, coordinators, working group and project chairs, governing board members, associate members and all organizations worldwide who support and sponsor IGS activities.**
- > **The IGS counts over 200 contributing organizations in more than 75 countries.**



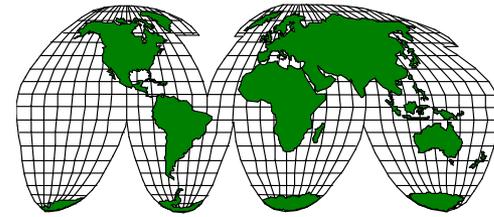
Outline of Presentation

- **Mission and Description of IGS**
- **Brief History**
- **New Strategic Plan**
- **Organization**
- **Projects & Working Groups Overview**
- **Summary**

- **Supporting information -- Resource Sheets and Quick Reference Sheets as handouts**



WHY IGS?



- **Key factors in formation of IGS**

- > All geodynamics and geodetic organizations realized the potential of GPS by late 1980's
 - » *NGS played a key role in establishing a global GPS network*
- > Motivating goal: millimeter positioning in support of science & engineering anywhere in the world
- > Not one agency can or should assume the capital investment & recurring operations costs for the entire infrastructure
- > Join with key international partners to form federation, define cooperation, set standards, science quality driven
- > Implement a global civilian GPS tracking system for science and research
- > Global framework for virtually all regional network applications (SCIGN, EUREF, SIRGAS, etc.)



Brief History of IGS

- **CIGNET (Coordinated International GPS Network)**
 - > ~1987, an activity of CSTG, led by Gerry Mader, NGS
- **Coordinated, standardized permanent network discussed at IAG meeting in Edinburgh, Scotland, September 1989**
- **Planning Committee formed in early 1990 led by Prof. Ivan Mueller, then President of IAG**
- **GIG'91 (GPS for IERS and Geodynamics) Campaign, January '91, organized to support IERS/ITRF**
- **IGS Call for Participation (CfP) developed, proposals due May 1991**
- **IGS Oversight Committee formed at Vienna 1991 IUGG meeting, Prof. Gerhard Beutler elected to Chair, oversee demonstration campaign**
- **IGS Pilot Campaign Demonstration June 21 - Sept 23, 1992 was highly successful, proof of concept and validation of CfP Proposals**
- **IGS approved as a permanent service of IAG in 1993**
- **Formal organization established in January, 1994**
- **Progress documented in IGS Annual Reports, available at IGS website**



IGS Mission & Objectives

‘... committed to providing the highest quality data and products as the standard for global navigation satellite systems (GNSS) in support of Earth science research, multidisciplinary applications, and education. These activities aim to advance scientific understanding of the Earth system components and their interactions, as well as to facilitate other applications benefiting society....’

- **International network of over 300 GPS stations are used to produce:**
 - > **High accuracy GPS satellite orbits (-3-5 cm 3-d wrms)**
 - > **Coordinates and velocities of the IGS tracking stations**
 - > **GPS satellite and tracking station clock information**
 - > **Earth rotation parameters, ionospheric, tropospheric information**
 - > **Derived products in support of science applications and novel projects**



Long Term Goals and Objectives

- **Provide the highest quality, reliable GNSS data and products, openly and readily available to all user communities.**
- **Promote universal acceptance of IGS products and conventions as the world standard.**
- **Continuously innovate by attracting leading-edge expertise and pursuing challenging projects and ideas.**
- **Seek and implement new growth opportunities while responding to changing user needs.**
- **Sustain and nurture the IGS culture of collegiality, openness, inclusiveness, and cooperation.**
- **Maintain a voluntary organization with effective leadership, governance, and management.**



Strategies of the IGS 2002-2007

To achieve the long-term goals and objectives of the IGS, three key strategies are identified:

- **Ensure delivery of "*world-standard*" GPS (and other GNSS) data and products, providing the standards and specifications globally.**
- **Pursue new opportunities for growth to improve the services and serve a broader range of users.**
- **Continuously improve the effectiveness of the IGS organization.**



IGS Organization



- **Recognized as a scientific service**
- **Advocates an open data policy**
- **Network of over 300 permanent precision geodetic receivers produce GPS data on a continuous basis,**
 - > **~100 report hourly, preparing subset for a real-time network demo**
- **Over 200 contributing organizations in 75 countries, many more users**
- **Approved activity of the International Association of Geodesy (IAG), January 1, 1994.**
 - > **Member of Federation of Astronomical and Geophysical Data Analysis Services, 1996 (FAGS)**
- **IUGG and ICSU recognition**
 - > **International Union of Geodesy and Geophysics**
 - > **International Council of Scientific Unions**

INTERNATIONAL GOVERNING BOARD



NAVSTAR GPS Satellites

Global Data Centers

Operational & Regional Data Center

Analysis Center Coordinator

Analysis Centers

Reference Frame Coordinator

Global & Regional Network and Associate Analysis Centers

IGS Projects and Working Groups

- IGS Reference Frame Working Group
- Precise Time & Frequency Transfer
- GLONASS Pilot Service Project
- Low Earth Orbiters Project
- Ionosphere
- Atmosphere
- Sea Level - TIGA
- Real-Time

Central Bureau at NASA/JPL
Management, Network Coordination,
External Relations, IGS Information System

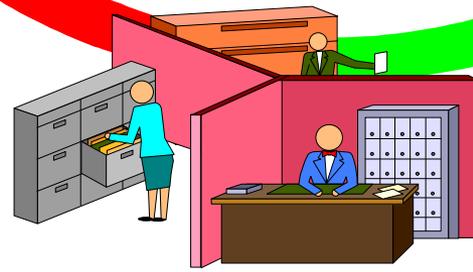
USERS
Practical, Custom,
Commercial, Governments,...

INTERNET

Telephone - Modem, Radio Links

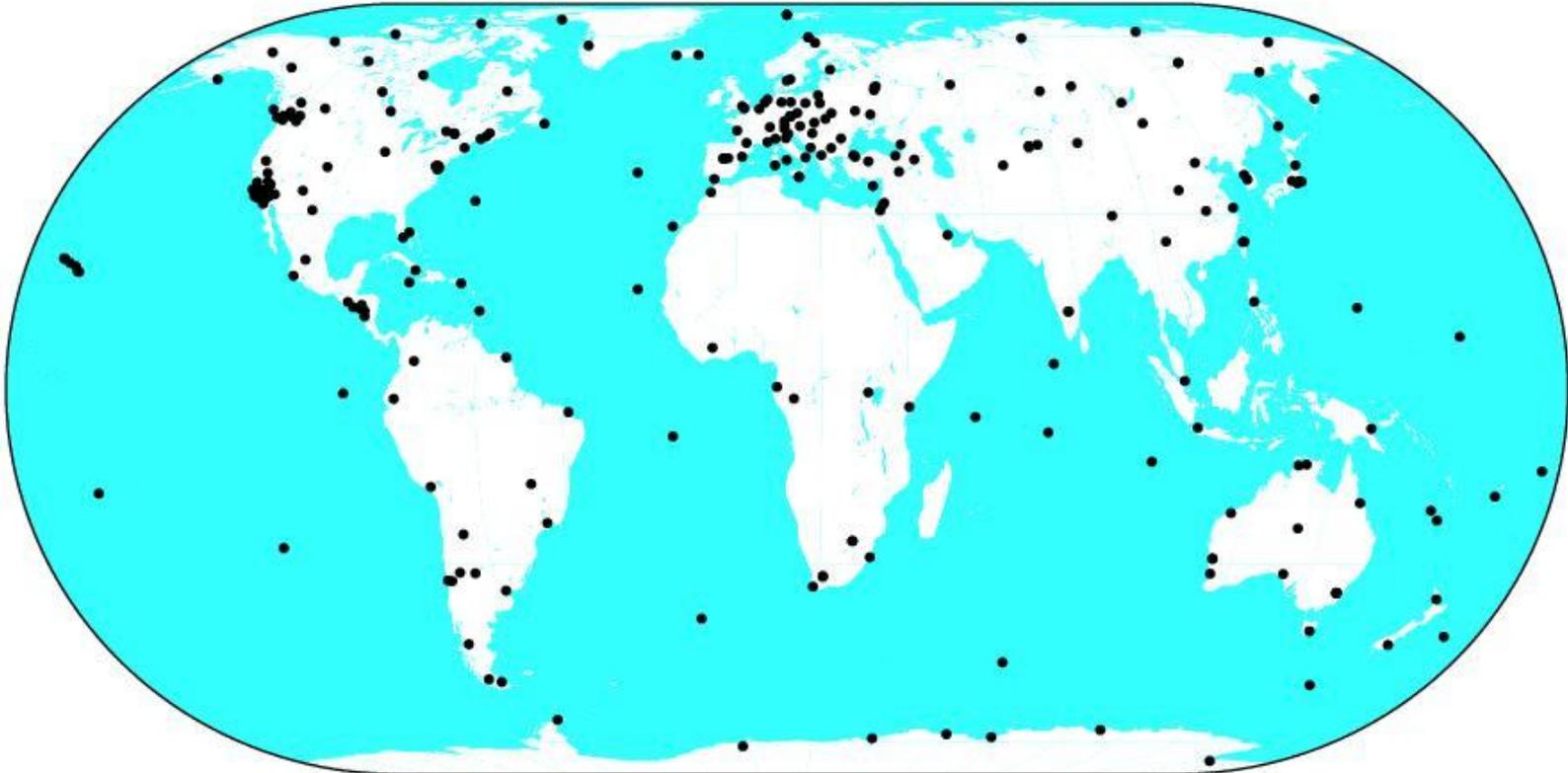
SATELLITE LINK

GPS Stations





IGS Tracking Network 2002

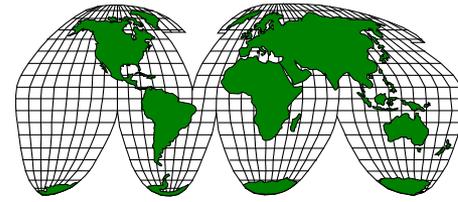


GMT Apr 15 14:54:48 2002

<http://igscb.jpl.nasa.gov/network/netindex.html>



Operations of the IGS



- **Operational Data Centers**
 - > Retrieve data from receivers
 - > Validate data and monitor station status
 - > Translate raw GPS data into RINEX (Receiver Independent Exchange)
 - > Forwards appropriate files to Global Data Centers or Regional Data Centers
- **Global Data Centers organize the files on the basis of site and time, and provide Internet data access to users and analysts**
- **IGS Analysis Centers pick up the data from the Global Data Centers, and estimate precise orbits, Earth Rotation parameters (ERP), clocks, etc.**
- **Analysis Center results are collected by the Analysis Coordinator and combined into the official IGS products**



IGS Projects & Working Groups

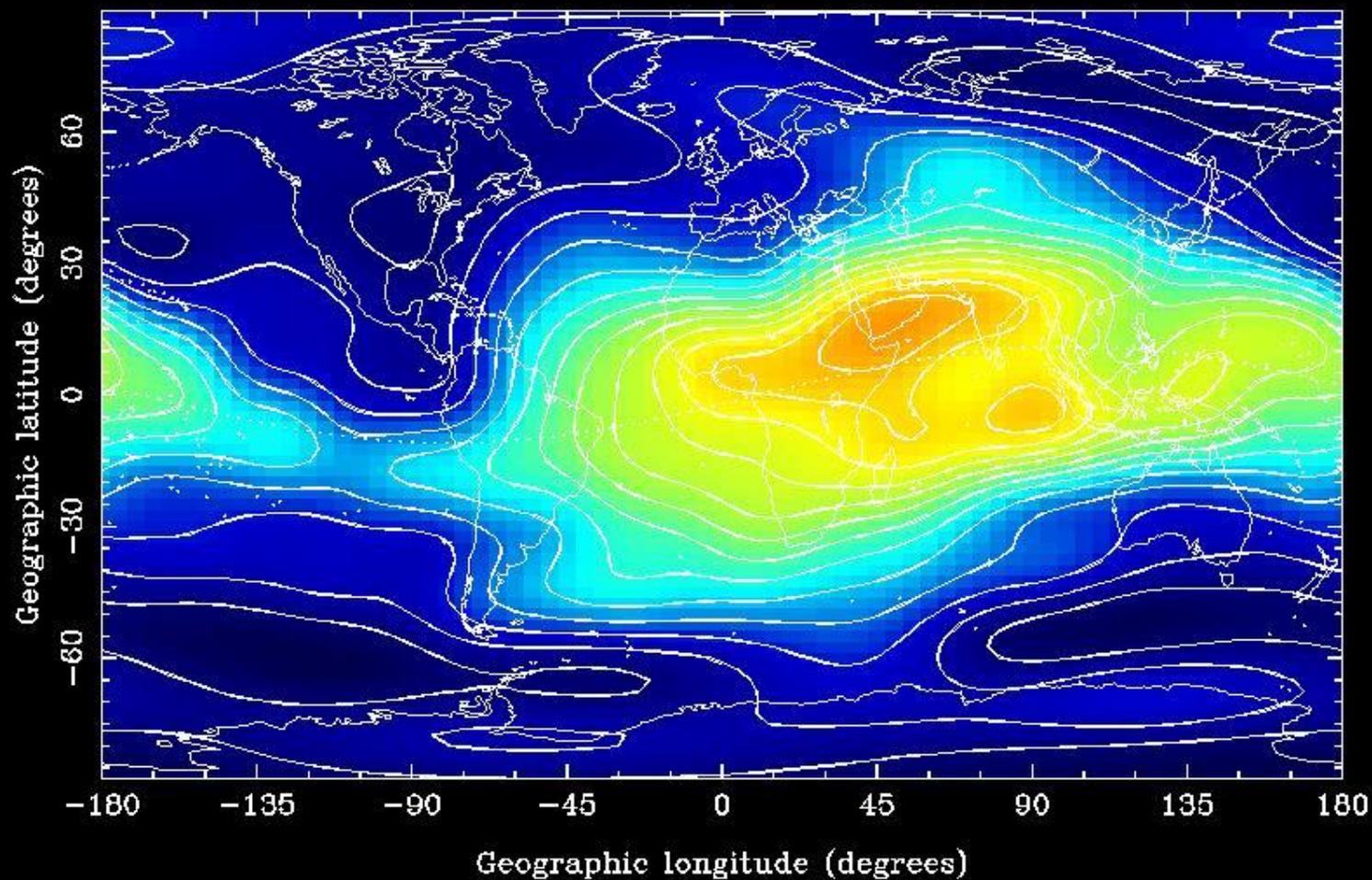
- **Reference Frame Densification**
 - > **Generate a robust and homogeneous reference system, relating scientific results anywhere in the world**
 - > **Plot network time series, position and velocities support plate motion and crustal deformation studies**
- **Precise Time & Frequency Project**
 - > **Exploit GPS measurements for improved accurate time and frequency comparisons worldwide, sub nanosecond**
 - > **Joint with the BIPM in France**
- **Low Earth Orbiter (LEO) Project**
 - > **Generate precise orbits for LEO satellites, Gravity (CHAMP, SAC-C, GRACE, JASON, etc.)**
 - > **Support occultation measurements for atmospheric profiling**
- **GLONASS Service Pilot Project IGLOS-PP**
 - > **Extensibility of IGS, 'classic' products for Russian GLONASS system**
- **Tropospheric Working Group**
 - > **Derive total zenith path delay or precipitable water vapor for GPS observations**
 - > **Ground-based meteorology, weather forecasting (severe storms), climate**



IGS Projects (con't.)

- **Ionospheric Working Group**
 - > Use dual frequency GPS data to determine Total Electron Content (TEC) including its temporal and spatial variations
 - > Daily measurements and maps of the Ionosphere
- **Sea Level Project - TIGA**
 - > **Measuring long-term motion of Tide-gauge Benchmarks**
 - » decouple crustal deformation or subsidence signatures at coastal areas from long-term sea-level changes, ocean loading effects
 - > **Support altimeter calibration at specific sites and inter-mission calibrations, TOPEX, JASON, etc.**
- **Real-time Working Group**
 - > Develop international standards for cooperation of real-time data exchanges
 - > Evaluate IGS involvement in real-time applications
- **AFREF Initiative - African Reference System**
 - > Develop a continental reference system based on sustainable technology for the African continent
 - > Establish the geodetic base for all development within Africa

CODE'S GLOBAL IONOSPHERE MAPS FOR DAY 274, 2001 - 11:00 UT



TEC (TECU)



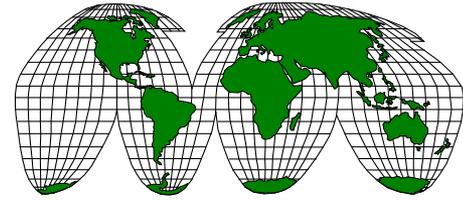
IGS Web Site

<http://igscb.jpl.nasa.gov>

- **The Central Bureau Information System is a key resource for all users**
- **One of the first websites in 1993, originally developed with Prof. Werner Gurtner, University of Bern**
- **IGSMail, IGS Reports, LEO Mail, AFREF Mail, IGLOS Mail, etc.**
- **IGS Directory, Calendar**
- **On-line access to all IGS publications**
- **Links to IGS sites and other locations of interest**
- **Rich FTP archives**
- **Tracking station information, site logs, network information**
- **FAQ**



Conclusion



- **The economics of GPS make the measurement technology readily available and accessible to all users**
- **The organization and outreach of the IGS enables users to take advantage of data, systems, and products developed cooperatively with the top international GPS experts**
- **Through the IGS standards are developed and adopted worldwide, contributing to robust, homogenous reference frame and implementing common processes**
- **IGS is a supporting global foundation for nearly all regional and national CORS networks, GPS projects and numerous applications worldwide**